Electra-Lite Mars Proximity Link Communications and Navigation Payload Description
04/06/2006

Electra Development Overview

The Mars Exploration Program (MEP) has identified the need for establishing a robust Mars infrastructure to provide mission-enabling and enhancing telecommunications and navigation services to future MEP elements. To this end, the Program has funded development of a standardized proximity link communications and navigation payload, known as the Electra UHF Transceiver (EUT), for flight on each strategic orbiter, starting with the 2005 Mars Reconnaissance Orbiter.

Electra will serve as the heart of a constellation of Mars network nodes efficiently relaying high rate in-situ mission science and engineering data, providing accurate navigation data and a precision timing reference for synchronizing spacecraft and in-situ assets that otherwise could not be achieved. Electra will be carried as a MEP-provided payload on future Mars science orbiters, starting with the 2005 Mars Reconnaissance Orbiter (MRO), providing a low-cost approach towards developing a Mars orbital communications infrastructure. After completion of their primary science mission, these spacecraft will continue to operate in Mars orbit utilizing the capabilities of the Electra payload to provide proximity link services to other elements of the Mars Program Electra-compatible transceivers (frequency band, protocols, encoding schemes etc.) will be installed on future Mars surface assets including landers, rovers etc. to provide an in-situ data link with Mars orbiters. The overall concept illustrating the Electra Payload operation is shown in Figure 1.

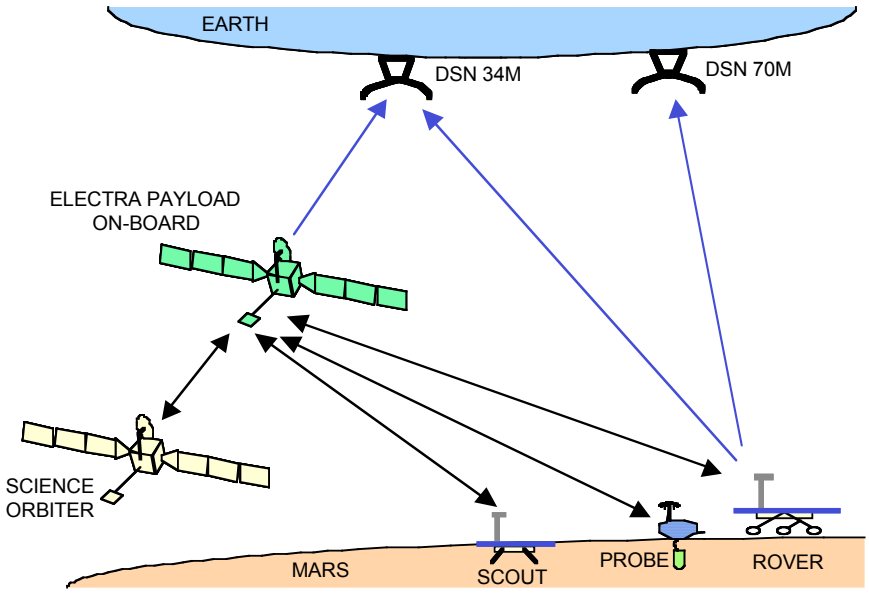

Figure 1: Electra Payload Operation Concept

Since the mass, volume and DC power specifications for the standard Electra EUT may be inappropriate for a Mars lander with stringent mass and energy constraints, a smaller lander UHF

radio is desired. This new development, referred to as Electra Lite (ELT), retains the core functionality, performance and reprogrammability of the standard orbiter EUT. The ELT design leverages the current Electra EUT design as much as possible, rather than designing anew "from the ground up", since there are several advantages to this approach, including:

- Assured compatibility with orbiter EUTs via use of common software/firmware
- Reduced non-recurring engineering costs (NRE) since the current EUT architecture will be maintained to the greatest extent possible
- Reduced recurring engineering costs. Parts commonality with the standard EUT provides a major reduction in EEE parts costs (shared lot and upscreen charges).
- Reduced ground support equipment (GSE) and Ground Data System (GDS) costs since the standard EUT GSE and GDS will be usable for Electra Lite integration and test and mission operation activities

ELT development is a collaborative effort between Jet Propulsion Laboratory (JPL) and L3Communications Cincinnati Electronics (L3CE). JPL is responsible for the software and firmware embedded in the Baseband Processor Module (digital slice), while L3CE is responsible for development of the remaining modules as well as integration, test and delivery of Engineering Model (EM) and Flight Model (FM) radios to the end user. The first FM ELTs will be delivered to the 2009 Mars Science Laboratory (MSL) Project in 2007 to accommodate an MSL 2009 launch.

Note that SCOUT mission proposers requiring UHF relay-communication capabilities are free to use any CCSDS Proximity-1 compliant radio. The purpose of this document is to simply ensure that proposers are aware of this MEP-developed technology.

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Electra Lite (ELT) Description

The Electra Lite UHF Transceiver (ELT), is a fully-reconfigurable, transceiver operating in the 390-450 MHz band. As shown in Figure 2, the ELT incorporates a modular design with functional elements residing in three stacked modules (from top down): A Receiver/Modulator (RFM) slice, a Baseband Processor Module (BPM) slice, and a Power Amplifier-Power Supply Module (P/A-PSM) slice. Key ELT specifications are provided in Table 1. The ELT command/response and data interfaces are shown in Figure 3.

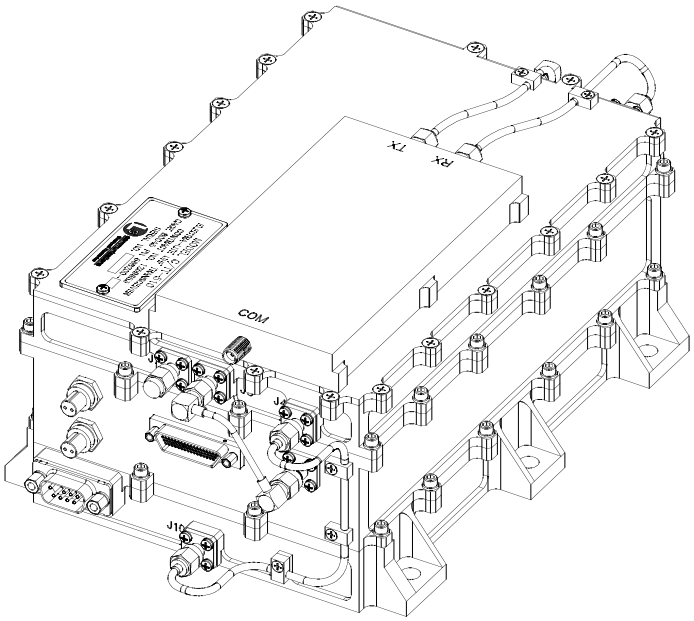

Figure:2 Isometric View of Electra Lite Transceiver

Parameter	Electra Lite
TX Frequency	390 to 405 MHz
RX Frequency	435 to 450 MHz
Duplex	Half OR Full
Operational Modes	FD: Rx, Rx/Tx
TX/RX Rate	1,2,4,8…4096 Ksps
Modulation	Manchester, NRZ-L, BPSK, QPSK (TBD), Mod Index 60 & 90
Coding	Reed Solomon, K=7, R=1/2 Conv Encode/Decode
Spectrum Record	Open Loop Signal Sampling < 100 KSPS, 1-8 bits/sample
RX Noise Figure	FD = 4.5 dB, HD=3.9 dB
RF TX Power	FD: 8.5 W; HD: 10.5W
Protocols	Proximity-1
Reconfigurability	Yes
Doppler Obs	1-way OR 2-way (HD, FD)
Mass	3000 gms (w/Diplexer)
Volume	~2872 cm^3
Dimensions (l,w,h)	20.3 cm × 13.1 cm × 10.8 cm
DC Power - RX Mode	18.5 (WC, EOL)
DC Power - TX/RX Mode	60.2 (WC, EOL)
Parts Grade	B+
TID	6.5 Krad (MSL Req't)

Table 1: Key ELT Specifications

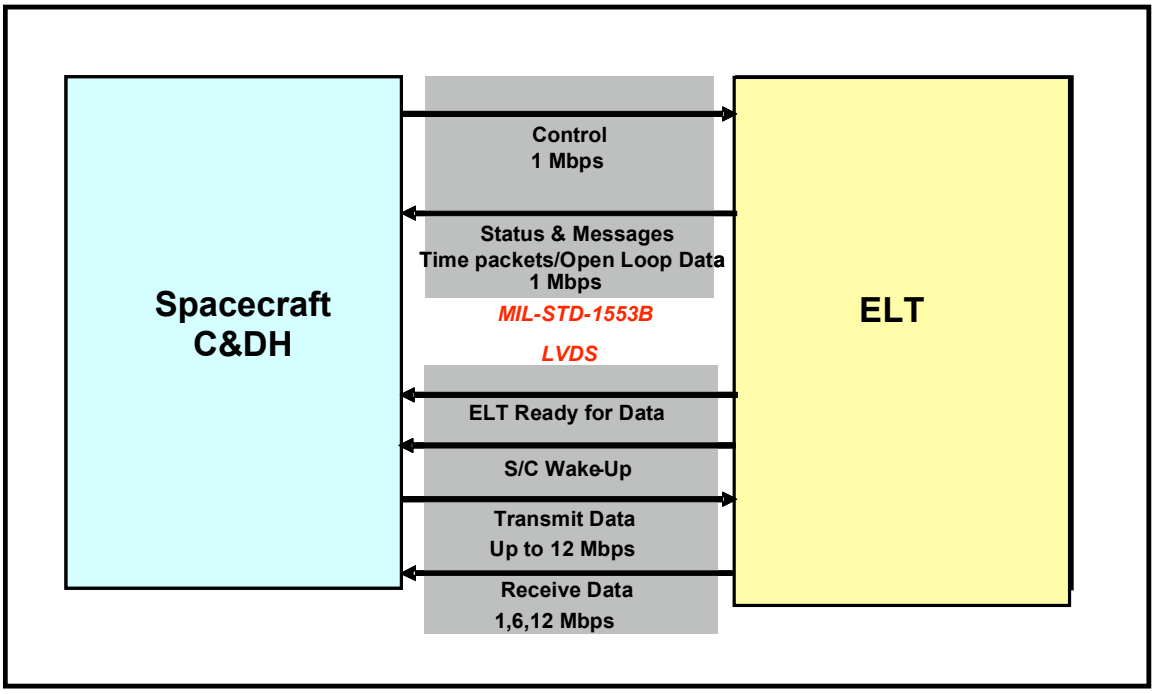

Figure 3: Electra Lite – Spacecraft Bus Interfaces